Space Weather Technical Forecast

Issued on Thursday, 18 July 2024 at 01:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: High to Moderate activity, with further M-class flares expected, and a chance of X-class flares. Chance of G1 Minor Storms late day 2 or more likely day 3 (19-20 Jul) due to CME arrival

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity, with a peak flare M5.0 at 17/0639UTC from AR3743 in the southwest, which resulted in an R2/Radio Blackout. There are a total of eighteen sunspots on the disc. AR3738 has now rotated around the west limb, although will remain a significant flare risk for at least the next 24 hours. The largest and most complex region is AR3751 in the southeast, which consists of a few weak delta spots, although has shown some consolidation of its spots. However, the most active region is AR3743 in the southwest. While at first glance, this is a relatively small region, this recently produced the aforementioned M5-flare and continues to show some ongoing slow development, along with a complex magnetic structure that connects to nearby AR3745 and AR3747 to its south. Other regions of note include AR3753 And AR3744 in the northwest, as a source of recent M1 and M2 flares, and the subsequent CME. The remaining regions are small and stable.

A few coronal mass ejections (CMEs) have been observed and analysed. The first, was a broad asymmetric halo and also a more typical cone to the northeast, that have both been attributed to the M1.9 at 16/2206 UTC. While the halo is likely mostly shock, these are both Earth-directed, likely arriving very late on day 2 (19 Jul) or early day 3 (20 Jul). A further CME likely occurred with the M5.0 flare, although this appeared very weak and faint in imagery. A prominence eruption occurred off the southeast limb at 17/1900 UTC, which also produced a CME, although given its location, it's unlikely to have any Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, was at background levels, ranging between 340-390 km/s. Density was average or below. The Interplanetary magnetic field (IMF), Bt, was initially moderate at 8nT, but declined to weak from 17/0700 UTC. The north-south component (Bz), varied between +6/-6nT. Phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet throughout (Kp 0-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels. The 24-hour fluence was below Active, with 1.02e6 integrated pfu observed at 18/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: High to Moderate activity with further M-class flares likely, and a chance of X-class flares. This is due to an on-going chance of X-flares from AR3738, which will only recede later on day 1 (18 Jul), as the magnetic looping of the spot retreats further over the western limb. Further occasional M-flares are expected throughout, with a slight chance of X-class flares.

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Solar Wind /Geomagnetic Activity: The CMEs from the M1.9 flare at 16/2206 UTC have been assessed as Earth-directed, likely arriving late on day 2 or early day 3 (19-20 Jul). Any fast wind from CH54/- is most likely to remain north of Earth, but with the potential for slight enhancements days 1-2 (18-19 Jul) with a chance of brief spells of slightly elevated winds. Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a slight chance of Active and very slight chance of G1 Minor Storm intervals days 1-2 (18-19 Jul). Any CME arrival is then expected to increase activity to Active with likelihood of G1-G2 Minor to Moderate Storm intervals, most likely late on day 2 (19 Jul) or day 3 (20 Jul). Becoming mostly Quiet to Unsettled by day 4 (21 Jul). Becoming mostly Quiet to Unsettled by day 4 (21 Jul), with chance of Active intervals, especially at first.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels, but with chance of rising above the S1/Minor Storm threshold in response to any notable flares, most likely from AR3738 before continuing to recede beyond the west limb. High energy electron flux is expected to remain at background, perhaps rising to Moderate briefly due to any fast wind connection, but likely suppressed again with any CME arrival. The associated 24 hr fluence is expected to remain below the Active level.

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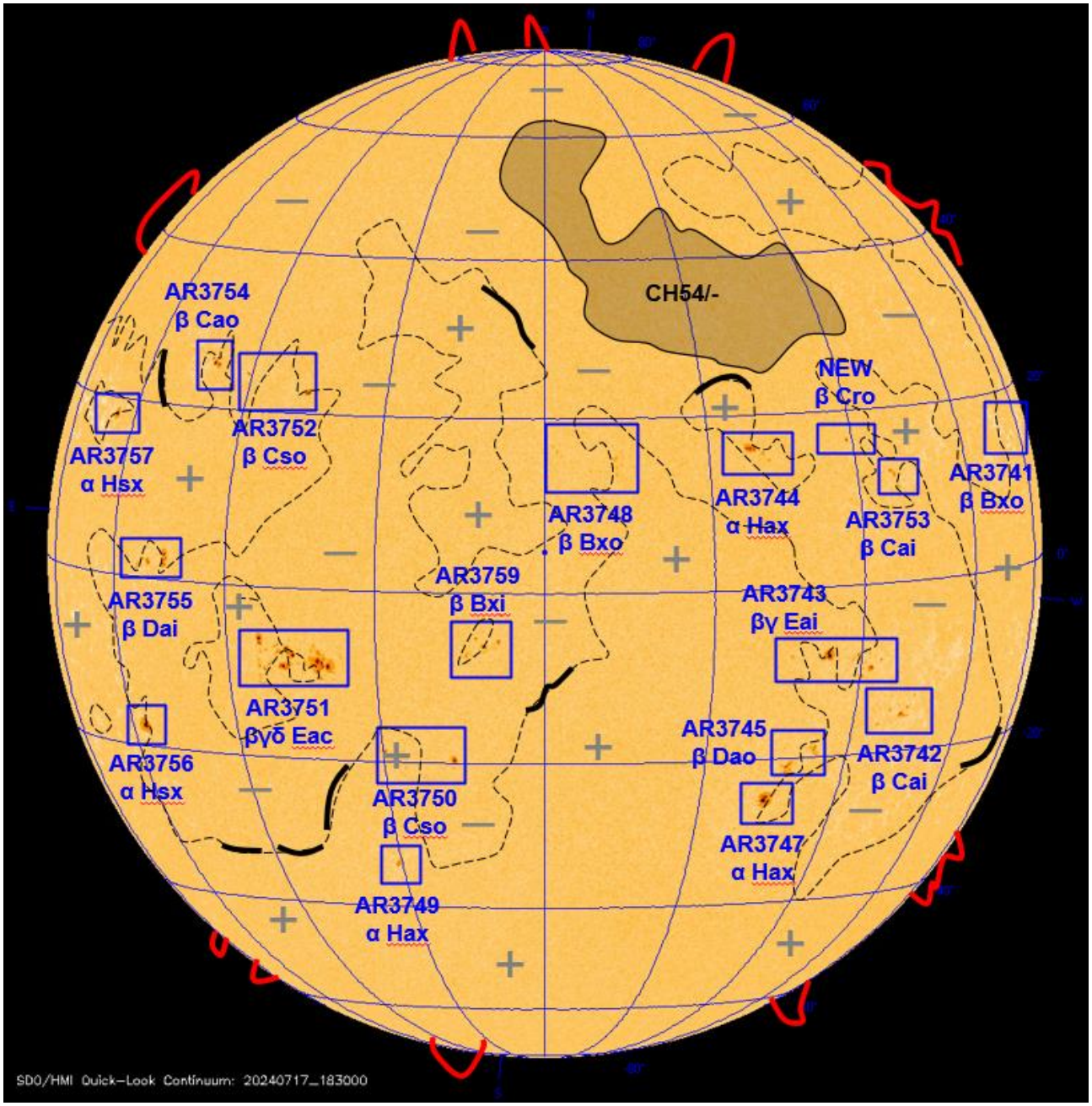
Figure 1. Solar Analysis Valid 17/1830 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

An M1.6 flare from AR3753 peaking at 16/2123 UTC in the northwest disc, was followed by an M1.9 flare from AR3744 at 16/2206 UTC. A subsequent double CME was observed, although it appears likely these were both from the second of these flares, with a main material ejecta to the northeast. This was followed with a very weak asymmetric halo CME which is possibly mostly shock, but has not been discounted for some material content. These are subsequently expected to arrive either late on day 2 (19 Jul) or more likely early day 3 (20 Jul).

This was followed by further flares, including a double peaked M5.0 flare from AR3743 at 17/0639 UTC and AR3753 at 17/0707 UTC. Available imagery is currently inconclusive for any CME release, however two weak Type II radio bursts were observed, suggestive of a CME release, and given the location of these regions, these are likely to be Earth-directed.
The fast wind from CH54/- is also something of an unknown, although the CH was present on the last rotation, there was no obvious increase in wind speed from it. The coronal hole is likely too far north to interact with Earth, though due to its size, clarity and persistence, a slight chance of a solar wind enhancement is also catered during days 1-2 (18-19 Jul). MOSWOC Enlil is currently poor, over-estimating the enhancement.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a slight chance of Active to G1 Minor Storm intervals days 1-2 (18-19 Jul) should any fast wind enhancement from CH54/- be observed. Any CME arrival is then expected to increase activity to Active with likelihood of G1-G2 Minor to Moderate Storm intervals, most likely on day 3 (20 Jul). Any CME effects gradually waning on day 4 (21 Jul), perhaps initially Active intervals, reducing to mostly Quiet to Unsettled conditions.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	20	60	20
Strong	G3	No	1	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/0334	Nil	M1.9 AR3744	N-centre	691 km/s	19/2200 -6/+12 hrs	Likely combine with below CME.
17/0400	Asymmetric Halo	M1.9 AR3744	N-centre	530 km/s	19/2200 -6/+12 hrs	Possibly mainly shock, but will combine with above

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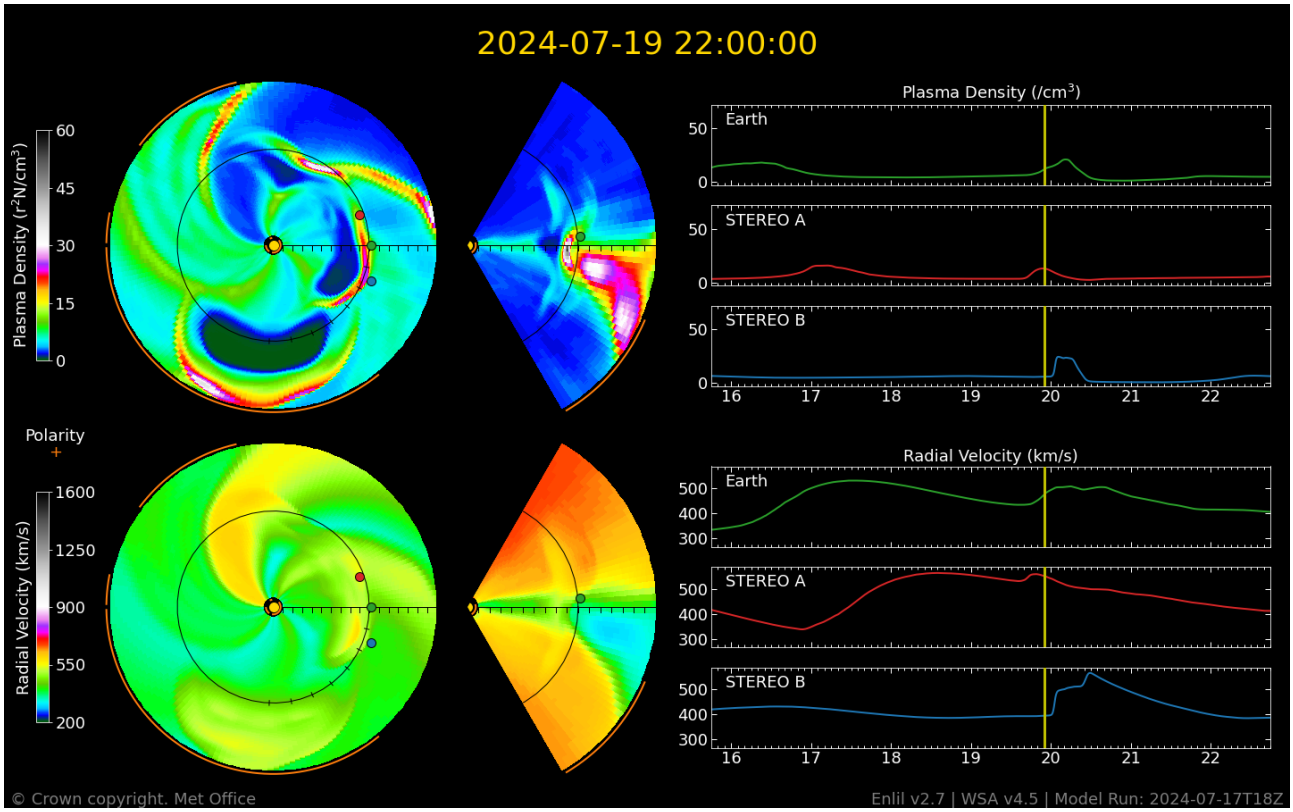
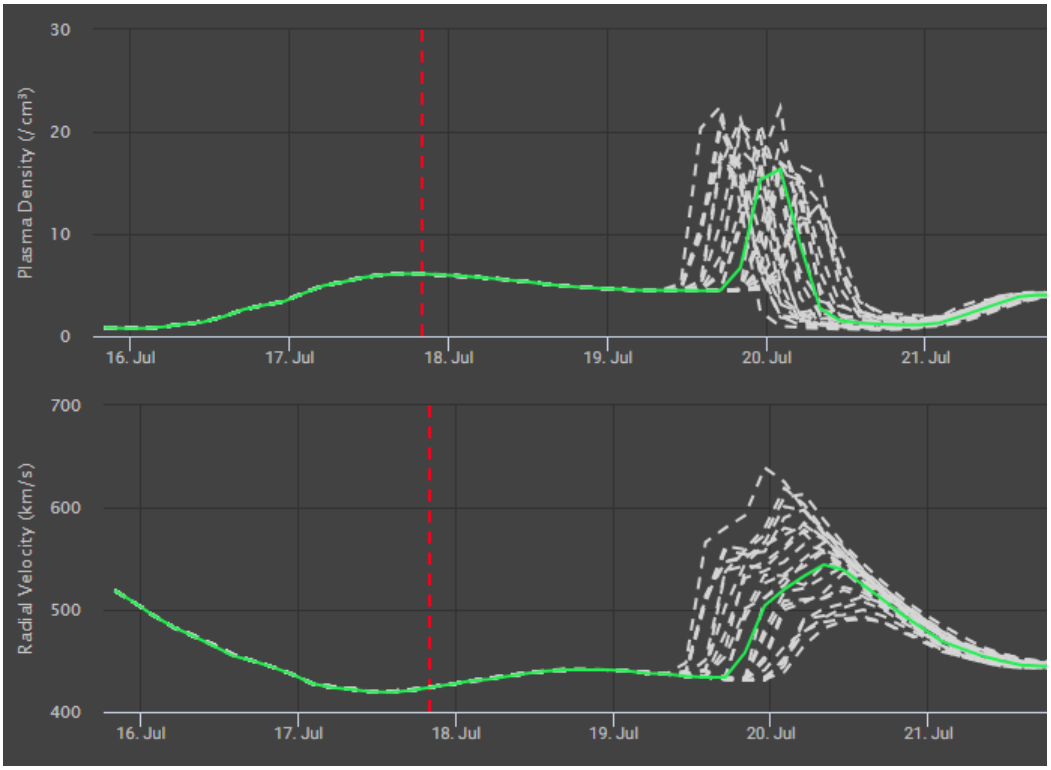
Figure 2: MOSWOC ENLIL and Ensemble – shows likely arrival of CME late on the 19th or early 20th Jul, although Enlil is currently over-estimating the potential influence of CH54/-, which hasn't occurred yet.





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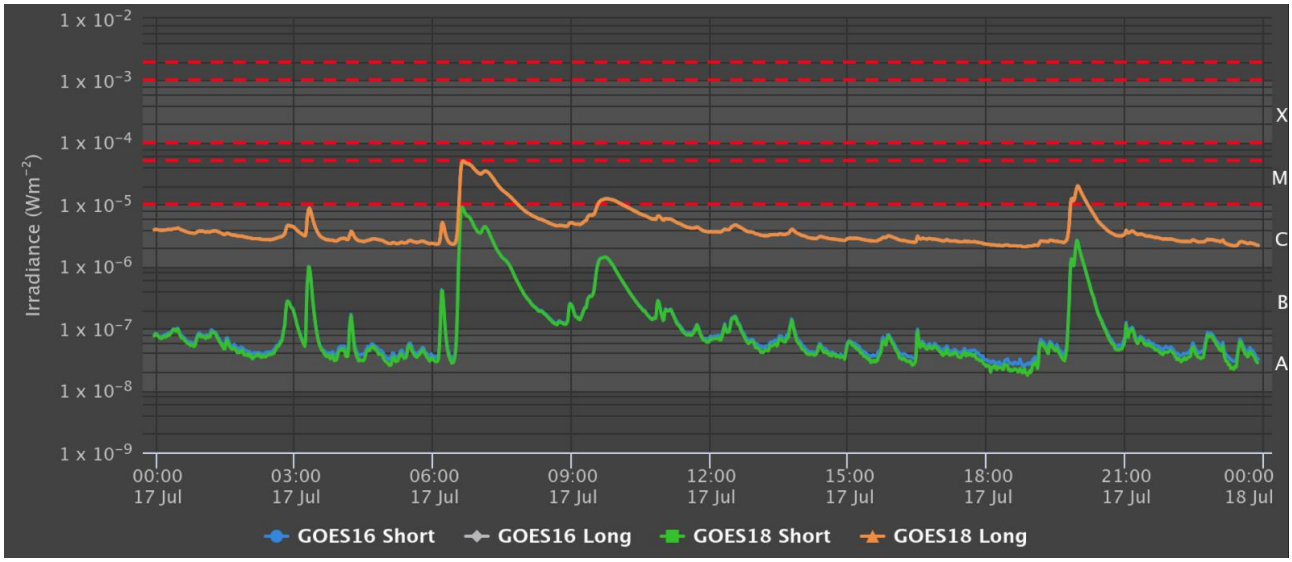
Radio Blackouts - X-Ray Flares:
Moderate with a chance of High activity is forecast at first, but likely becoming more generally Moderate from day 2 (19 Jul). This is due to an ongoing chance of X-flares from AR3738, which will only recede later on day 1 (18 Jul), as the magnetic looping of the spot retreats further over the western limb. Further occasional M-flares are expected throughout.

There are currently eighteen regions on the visible disc, however most of these are relatively small. A significant flare risk continues from AR3738 for at least the next 24 hours, now located just over the southwest limb, before any magnetic looping above the spot recedes around onto the far-side. The most complex region on the disc is AR3751 in the southeast, which consists of a small delta spot, although growth has stalled with its main spots consolidating. Aside from AR3738, the most active region is AR3743 in the southwest. While at first glance, this is a relatively small region, this recently produced an M5-flare and continues to show some ongoing slow development, along with a complex magnetic structure that connects to nearby AR3745 and AR3747 to its south. Other regions of note include AR3753 And AR3744 in the northwest, as a source of recent M1 and M2 flares, and the subsequent CME.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	60
Very Active	R3 to R5 X Class	No	15	10	10	10

Figure 3: GOES-18 X-Ray flux trace – shows the recent M-class flares.



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux at GOES18 is at background. There remains a slight chance of exceeding the S1/Minor radiation storm threshold should any significant flares occur from AR3738 while this remains in a good location at present for solar radiation events to connect with Earth, before receding further onto the far-side. However, recent X-class flares from this region have not produced any perceptible increases to the observed flux, decreasing confidence in this risk. A slight risk is maintained however due to the number of sunspot regions on the disc, including AR3743 and surrounding spots in the southwest, which produced an M5 flare on 17 Jul.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	10	10	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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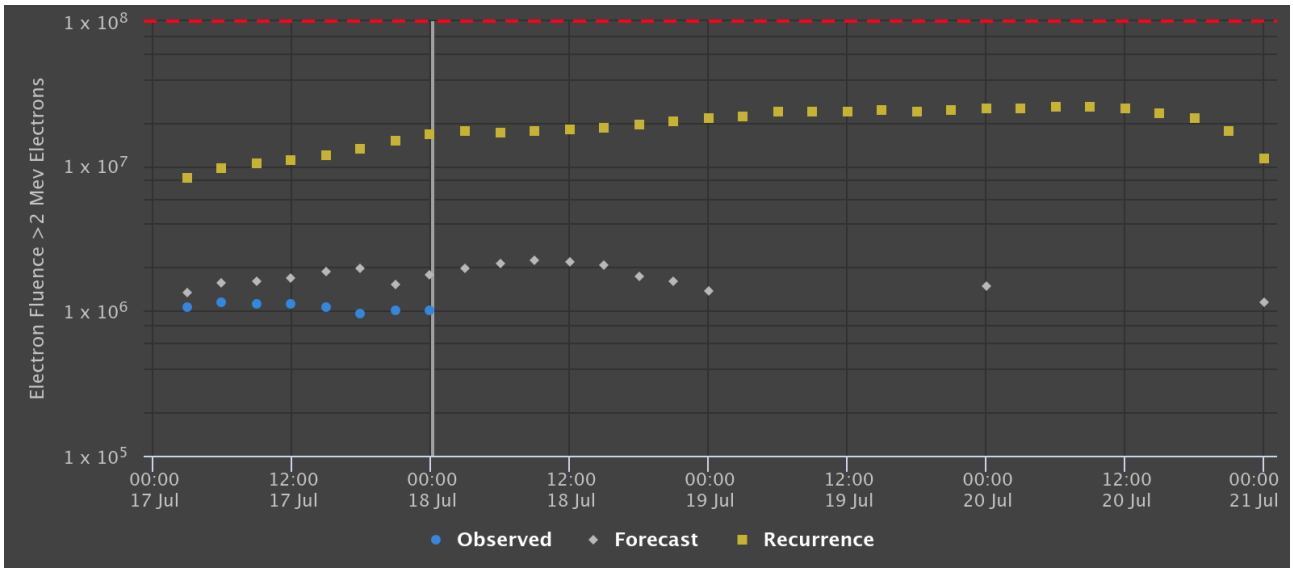
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux as observed by GOES-16 is expected to remain at background. Any subsequent fast wind connection may lead to flux rising to give spells of Moderate day 2 (19 Jul), however any increase is likely to quickly be suppressed by the onset of any CME arrival.

The associated electron fluence is expected to persist below the Active level with MOSWOC REFM currently providing good guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC electron fluence



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